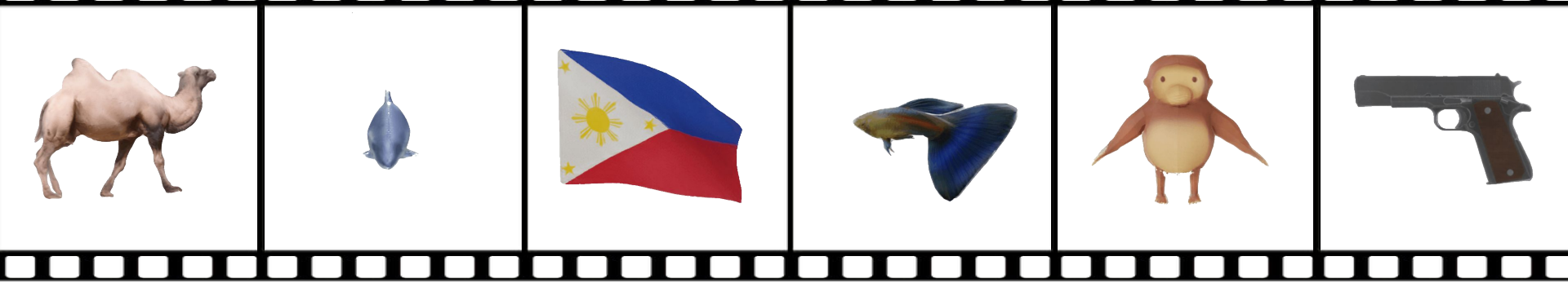


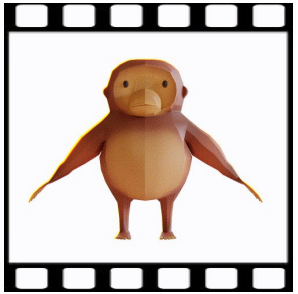
SV4D : Dynamic 3D Content Generation with Multi-Frame and Multi-View Consistency

Yiming Xie*, Chun-Han Yao*, Vikram Voleti, Huaizu Jiang^, Varun Jampani^

* Equal Contribution ^ Equal Advising

stability.ai

Dynamic 3D Content (4D) Generation



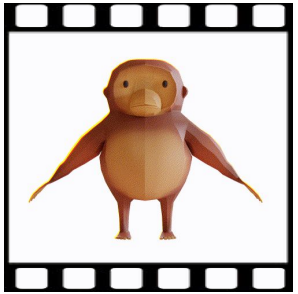
4D Generation

Input: Single-view Video

Output: 4D Representation

(Dynamic 3D representation, e.g, NeRF, Gaussian Splatting, Mesh...)

Dynamic 3D Content (4D) Generation



4D Generation

Input: Single-view Video

Output: 4D Representation

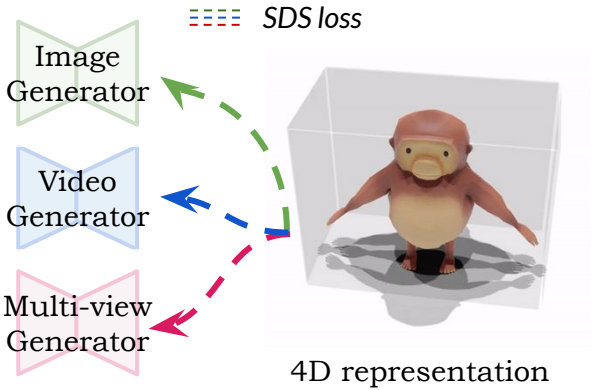
(Dynamic 3D representation, e.g, NeRF, Gaussian Splatting, Mesh...)

Challenges:

- The higher dimensional nature of 4D generation.
- No large scale datasets with 4D objects to train a robust generative model.

Dynamic 3D Content (4D) Generation

Related Works



SDS [1] based optimization

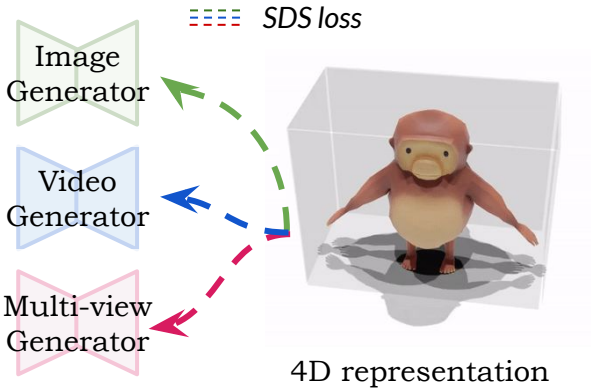
- Time-consuming: take hours to generate a single 4D object.
- Unstable optimization

MAV3D, Consistent4D, STAG4D, 4DGen

[1] *Dreamfusion [Poole, Ben, et al.]*

Dynamic 3D Content (4D) Generation

Related Works



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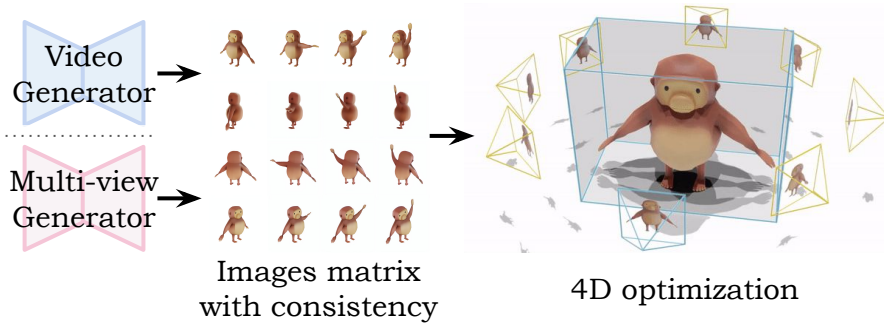


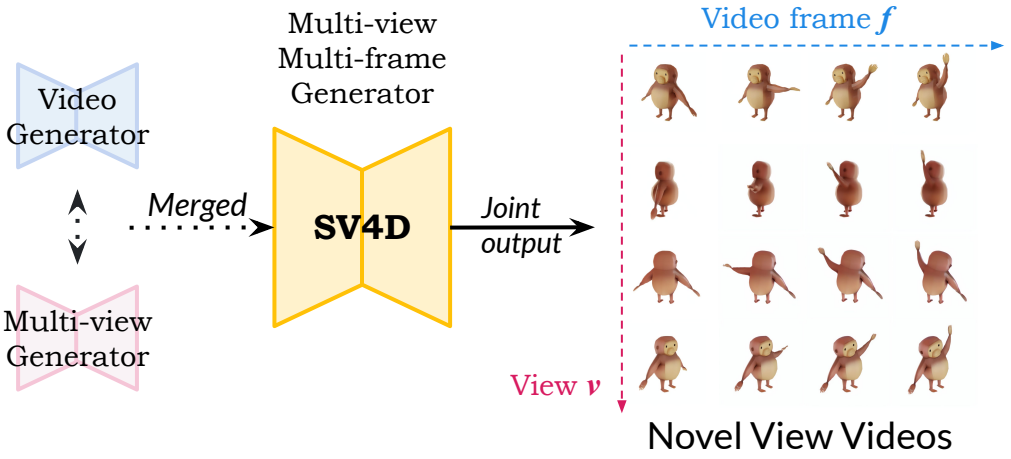
Photogrammetry-based methods

- Several inconsistencies still remain due to the use of separate video and multi-view generative models

Diffusion^2

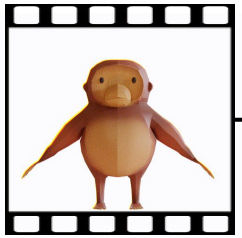
[1] *Dreamfusion [Poole, Ben, et al.]*

Our Solution

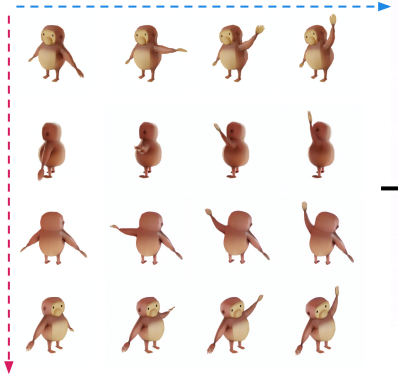


- State-of-the-art multi-frame and multi-view consistency.

Our Solution



SV4D



Input: Single-view Video

Novel View Videos

Output: 4D Representation

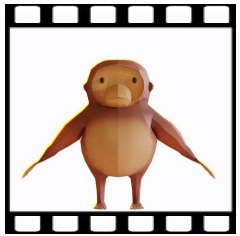
(Dynamic 3D representation, e.g, NeRF, Gaussian Splatting, Mesh...)

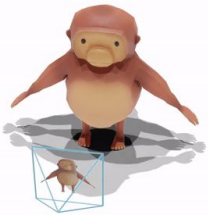
Novel View Video Synthesis

4D Optimization

Novel View Video Synthesis

Input Reference Video



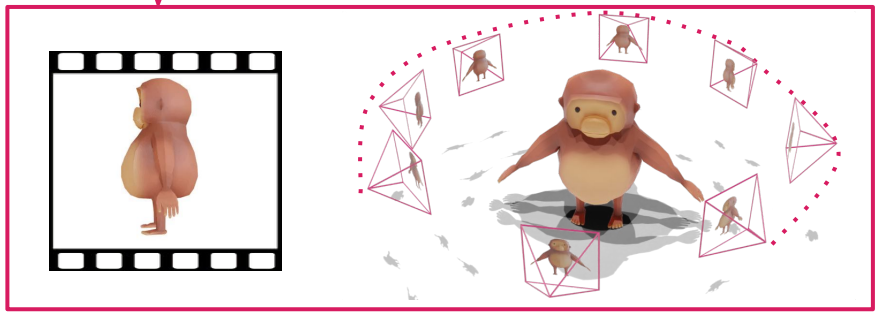


GT Mesh for illustration purpose only

Novel View Video Synthesis

Input Reference Video

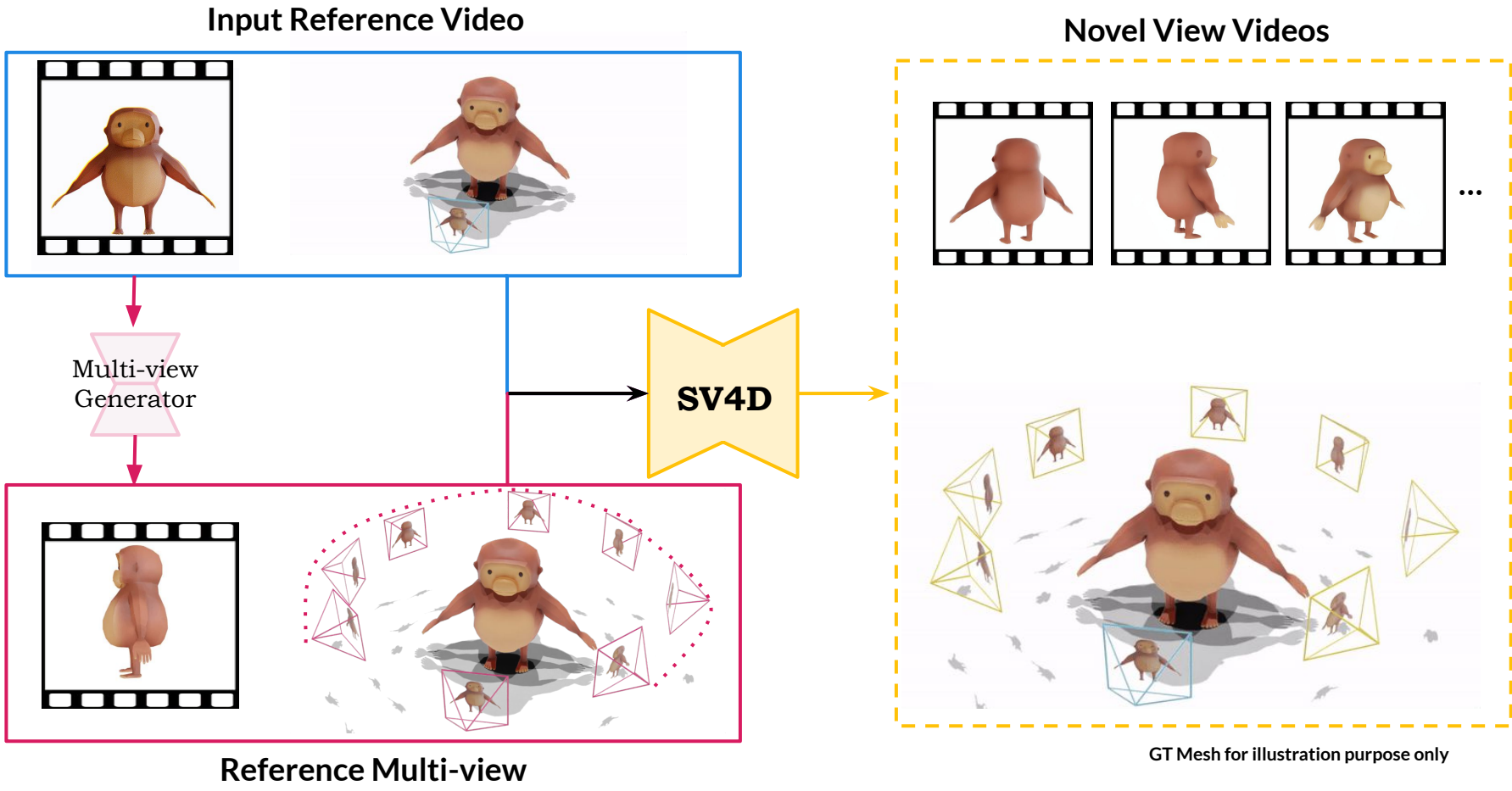
Multi-view Generator



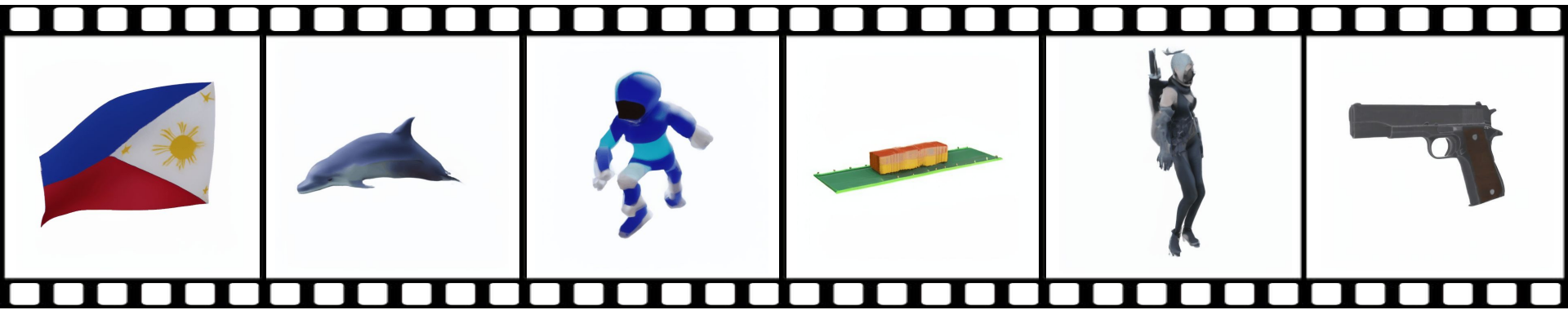
Reference Multi-view

GT Mesh for illustration purpose only

Novel View Video Synthesis



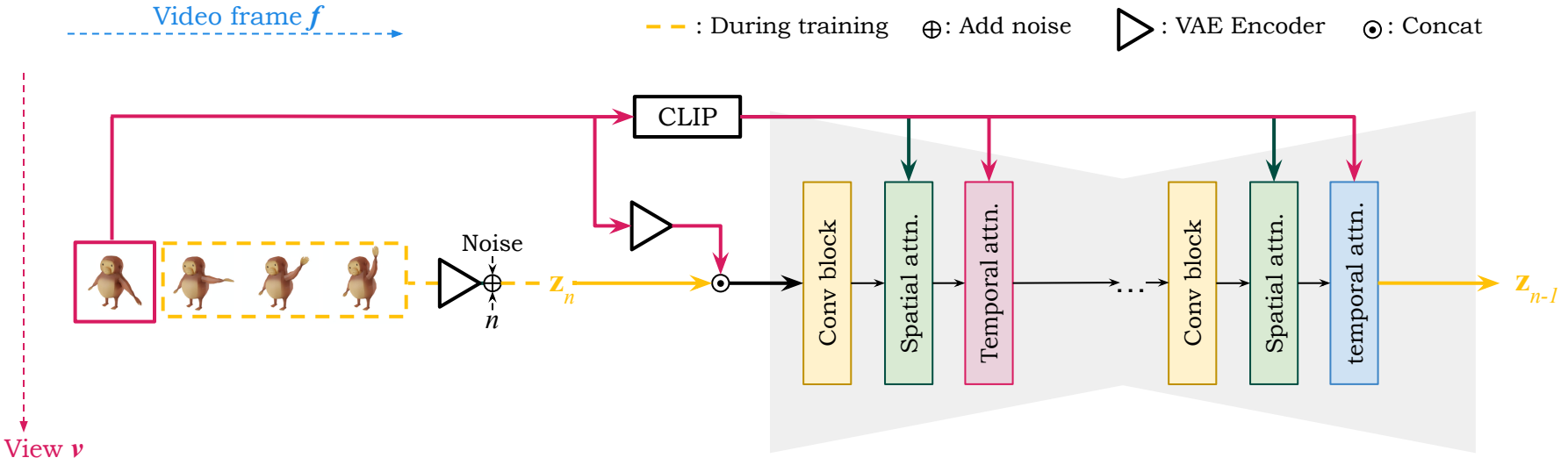
Novel View Video Synthesis



Novel View Video Synthesis

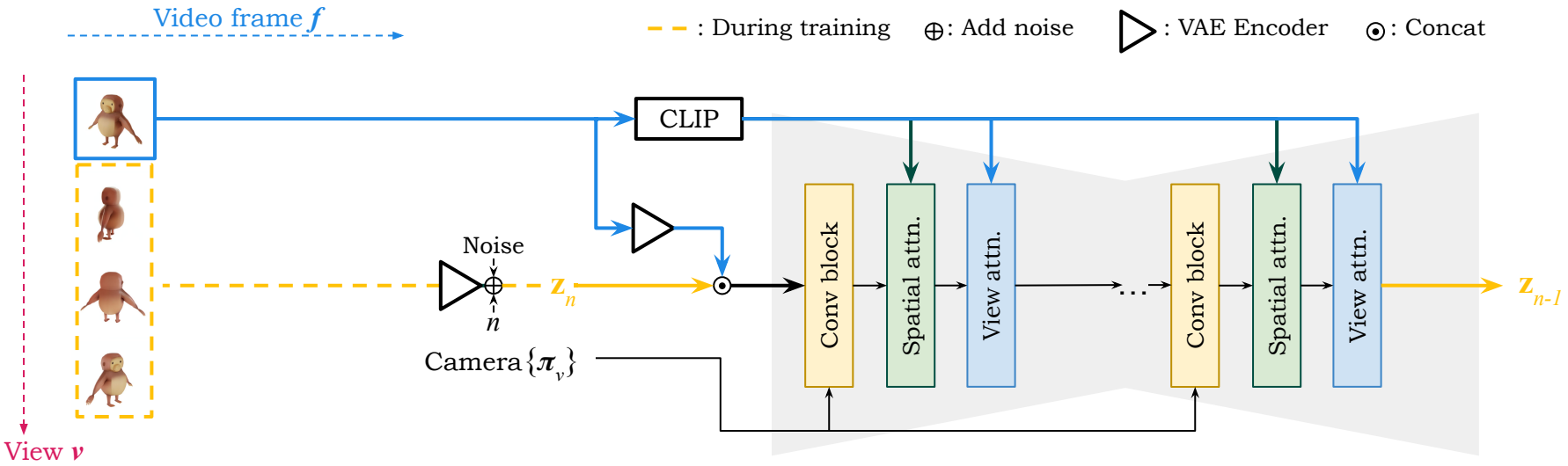
Novel View Video Synthesis

Stable Video Diffusion (SVD)



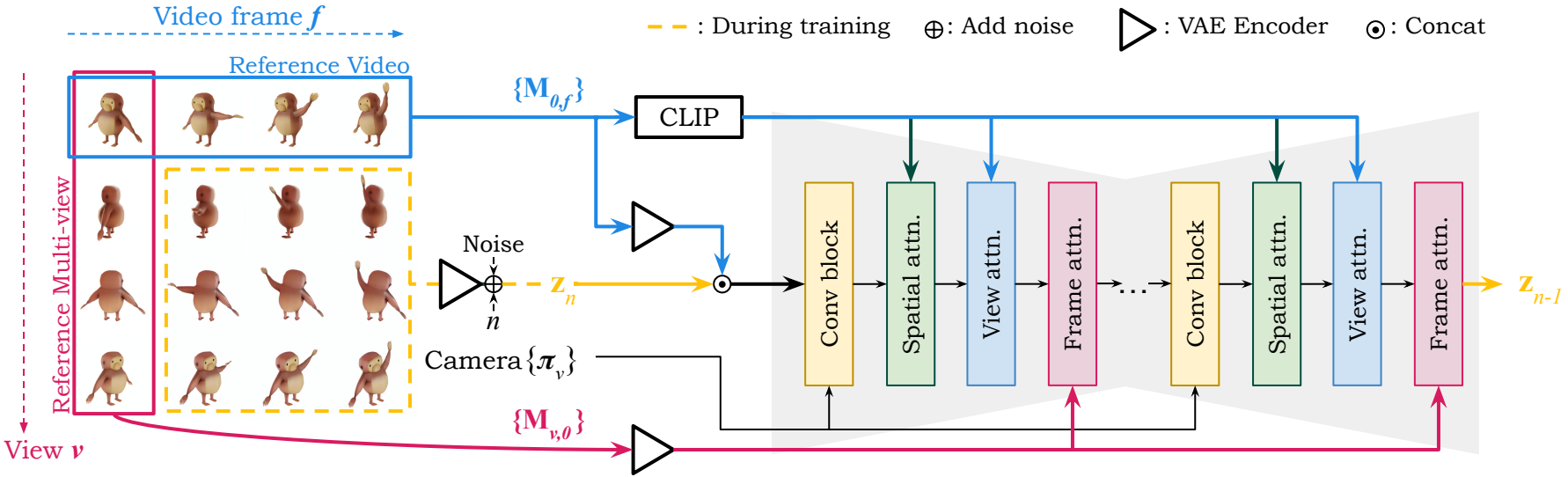
Novel View Video Synthesis

Stable Video Diffusion 3D (SV3D)



Novel View Video Synthesis

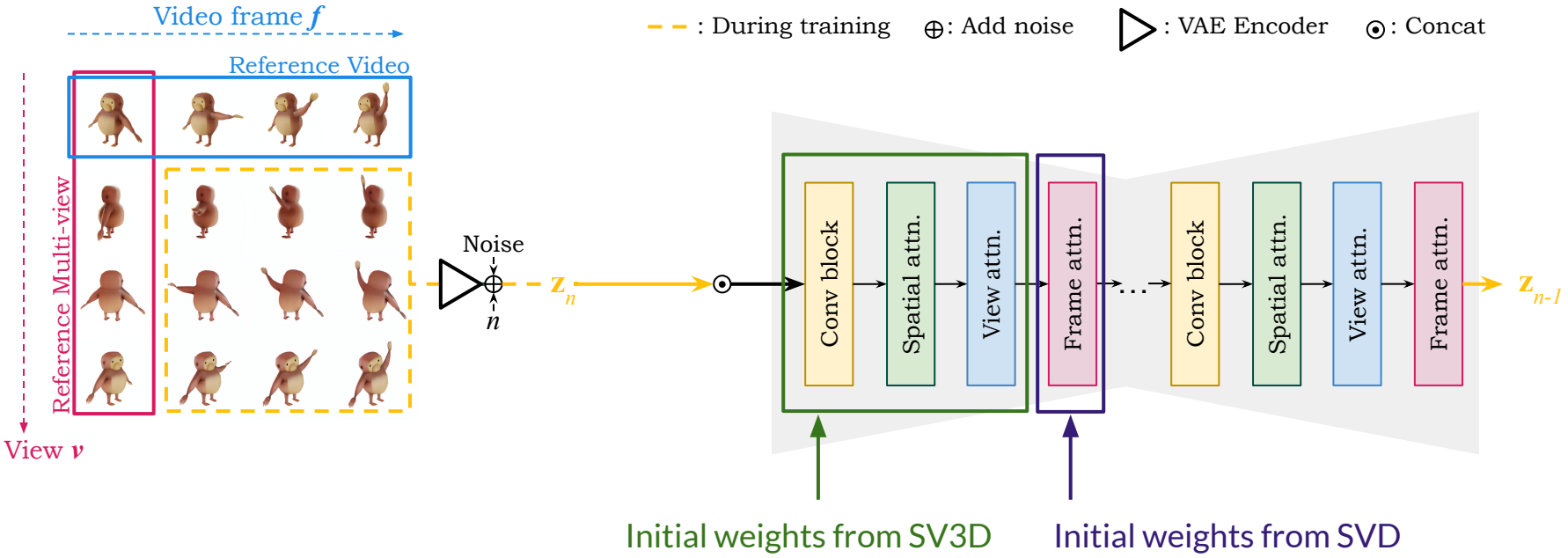
Stable Video Diffusion 4D (SV4D)



Novel View Video Synthesis

Training Details

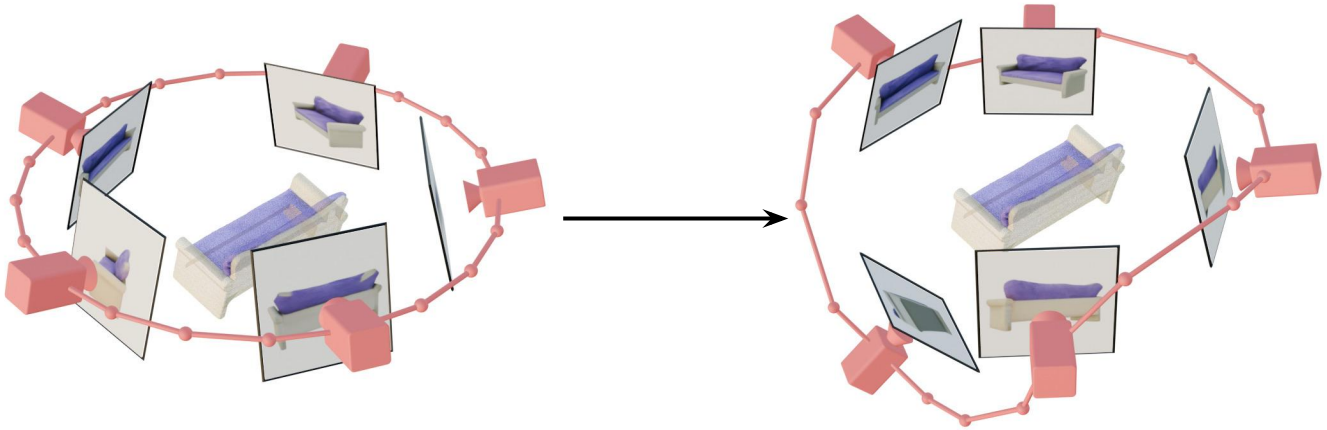
Resume weights from both SV3D and SVD



Novel View Video Synthesis

Training Details

Two-stage fine tuning



Static Orbit

Dynamic Orbit

***Figure Credit**: SV3D [Voleti, Vikram, et al.]*

Novel View Video Synthesis

Training Details

Training Dataset

Objaverse Dataset

includes over 44K animated 3D objects.

Improve data quality

Filtering

- Inappropriate licenses
- Too few animated frames
- Small movement

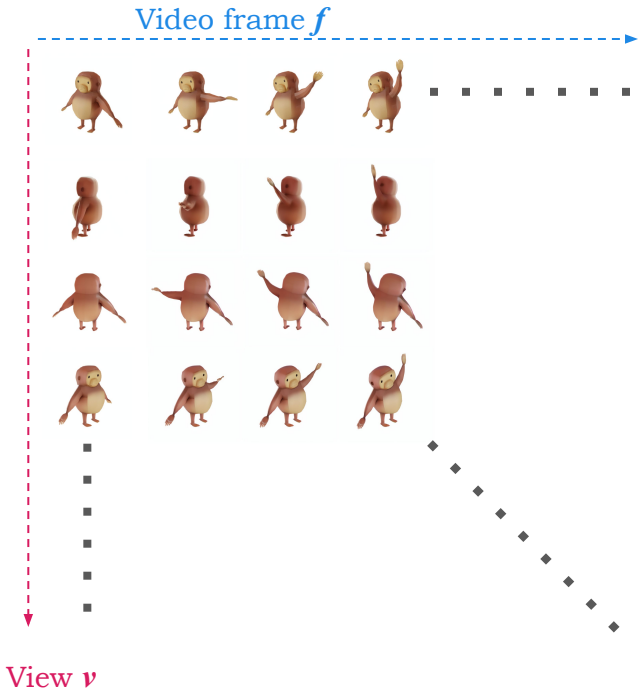
Rendering

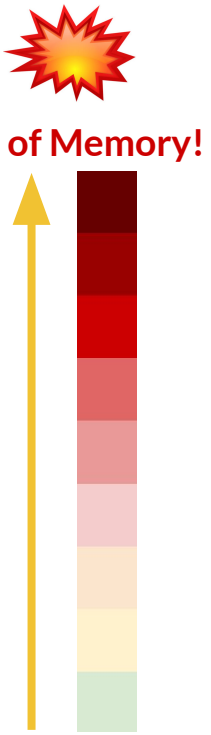
- Dynamically adjust frame sampling step for each object
- Dynamically adapt camera distance
- Remove global motion

***Figure Credit**: Objaverse-XL [Deitke, Matt, et al.]*

Novel View Video Synthesis

Generation for Arbitrary Length Videos



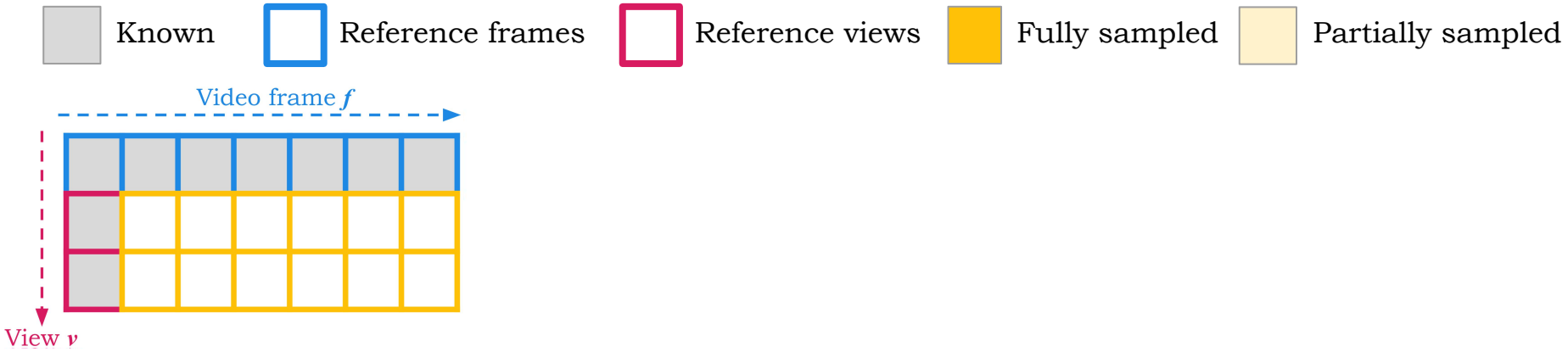


Large image matrix with long input video / view

GPU Memory

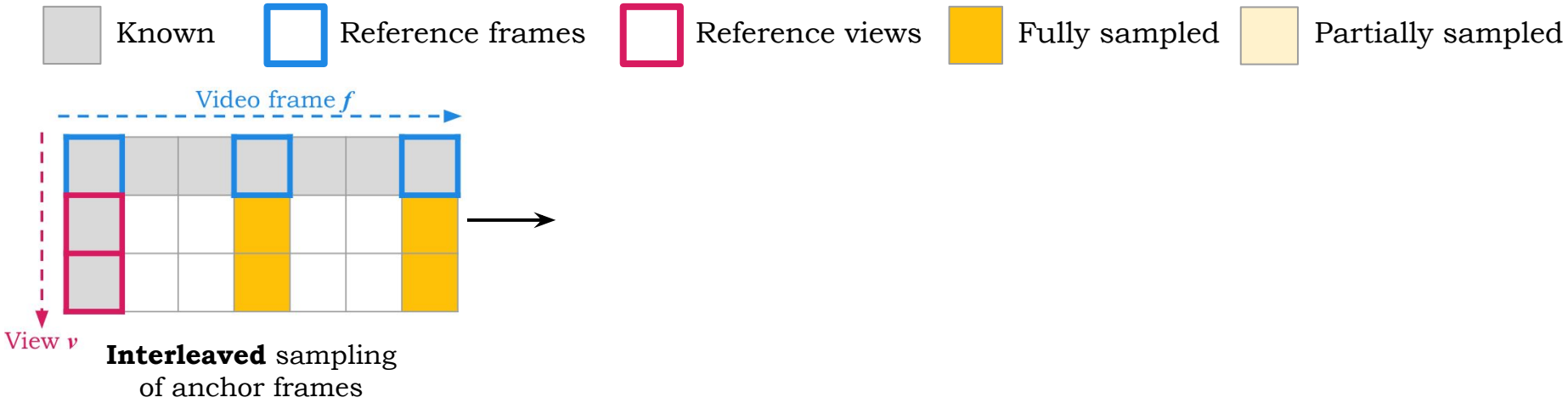
Novel View Video Synthesis

Generation for Arbitrary Length Videos



Novel View Video Synthesis

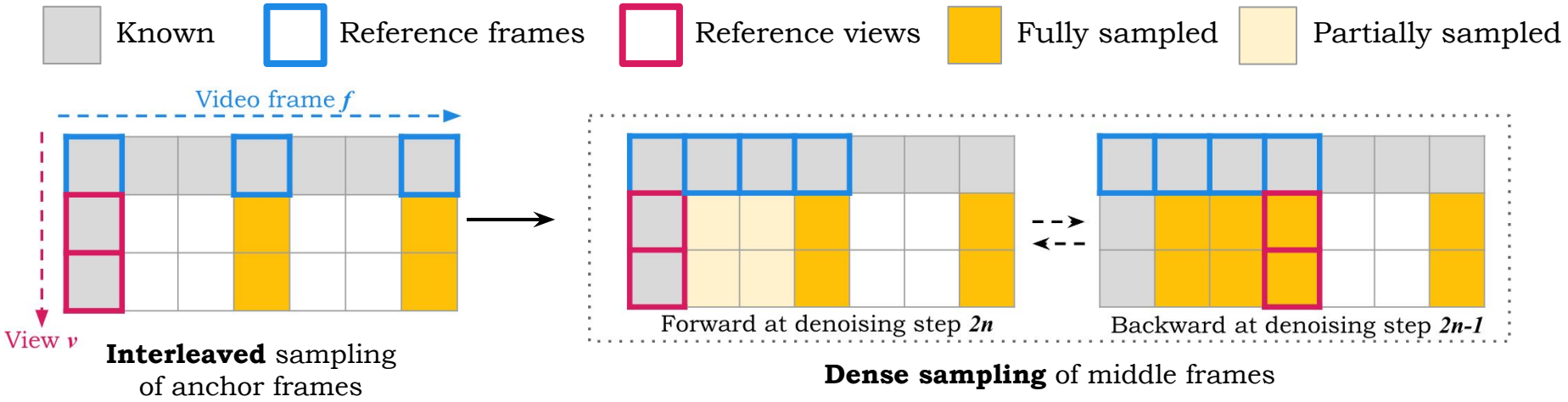
Generation for Arbitrary Length Videos



Interleaved sampling
of anchor frames

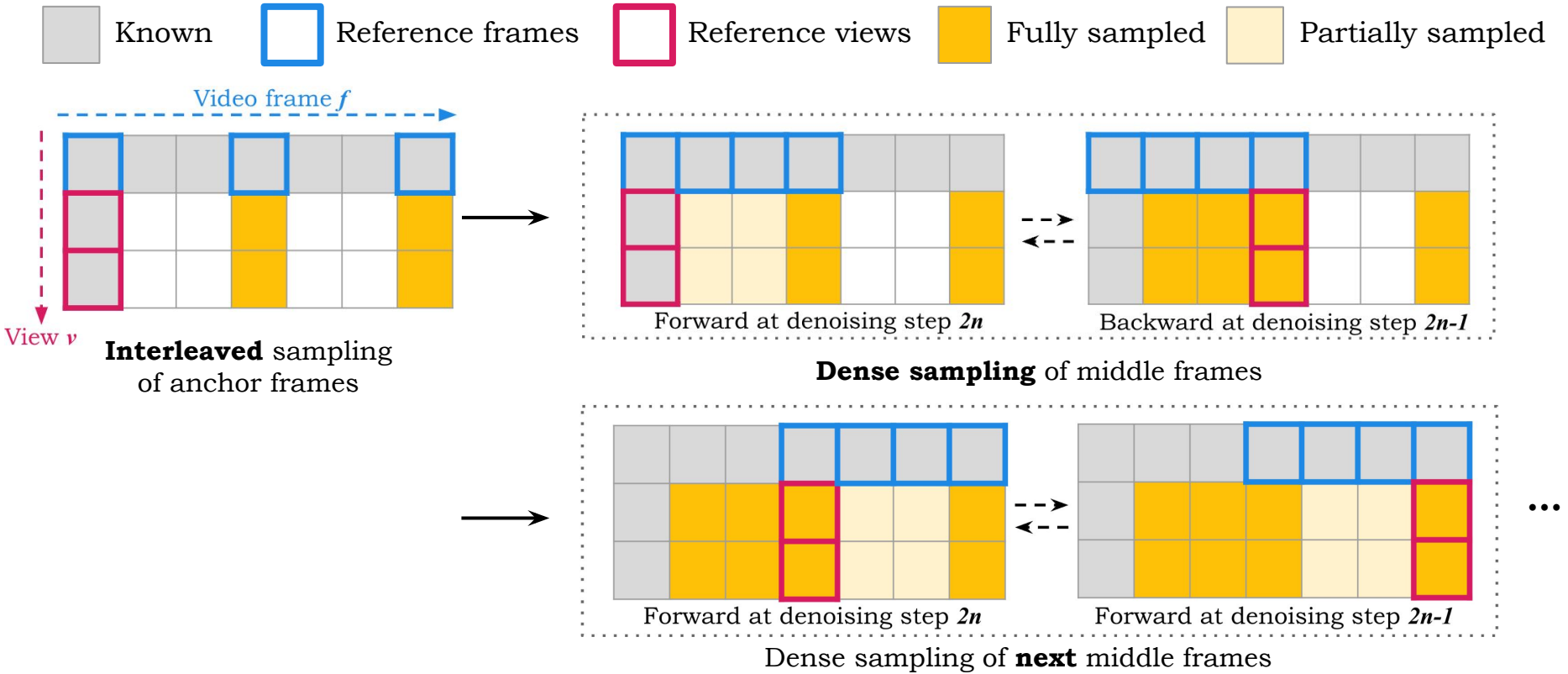
Novel View Video Synthesis

Generation for Arbitrary Length Videos

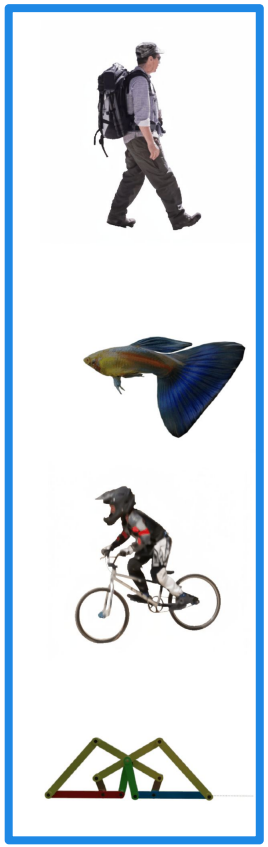


Novel View Video Synthesis

Generation for Arbitrary Length Videos



Novel View Video Synthesis



Input Video

Diffusion^2

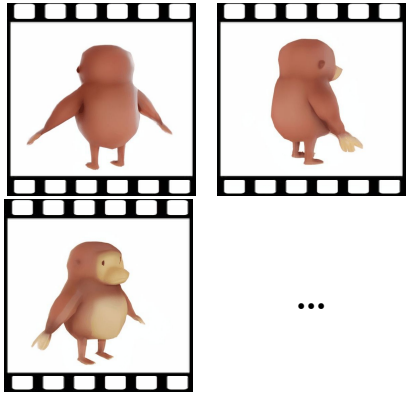
STAG4D

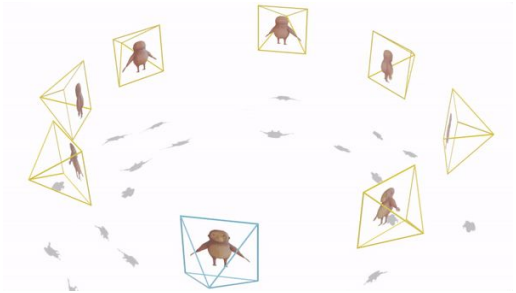
Stable Video 3D

Stable Video 4D (Ours)

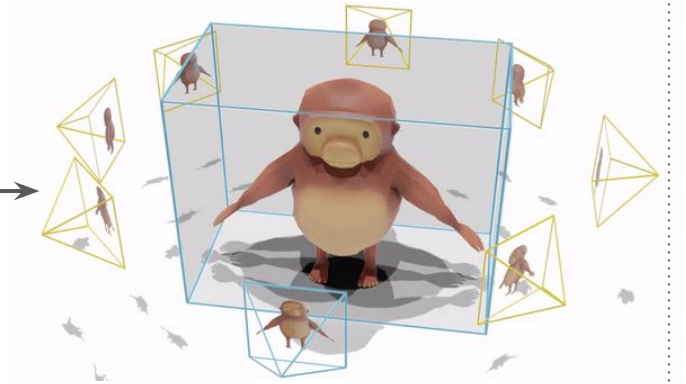
4D Optimization

Novel View Videos





4D Optimization



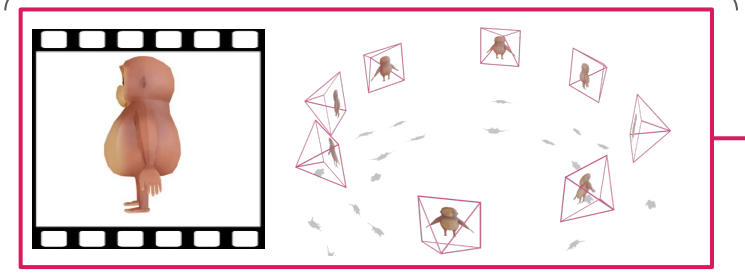
Canonical NeRF

Generated 4D Assets

4D Optimization

Dynamic NeRF representation

Stage 1 (static)



Reference Multi-view

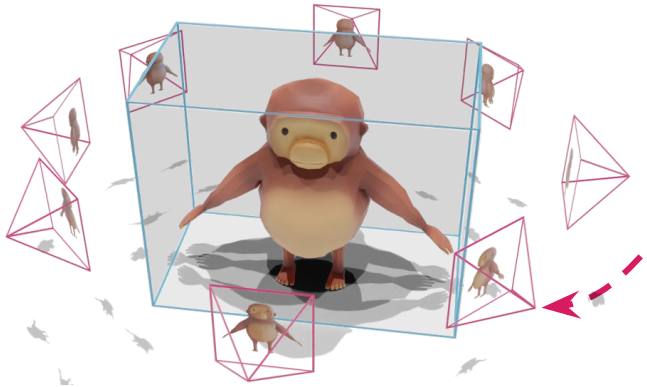


Image + Geometry Losses

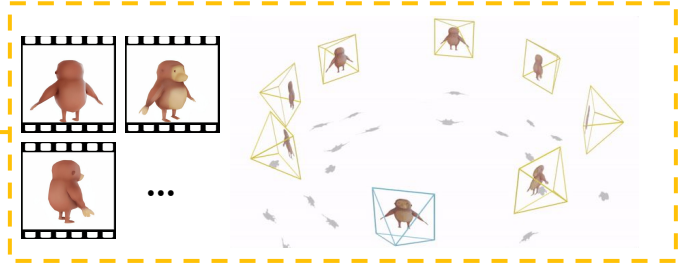
4D Optimization

Dynamic NeRF representation

Stage 1 (static)

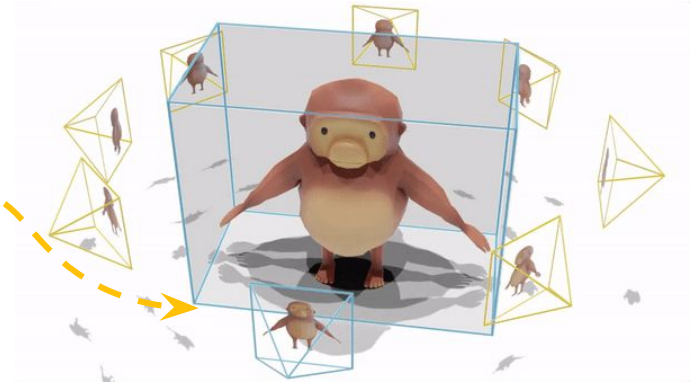
Reference Multi-view

Stage 2 (dynamic)

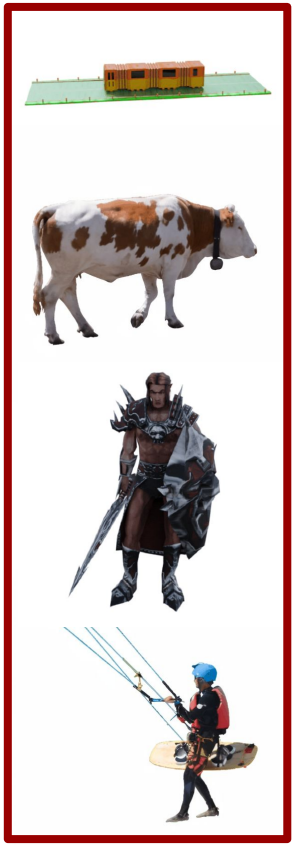


Random Views & Frames

Image + Geometry Losses



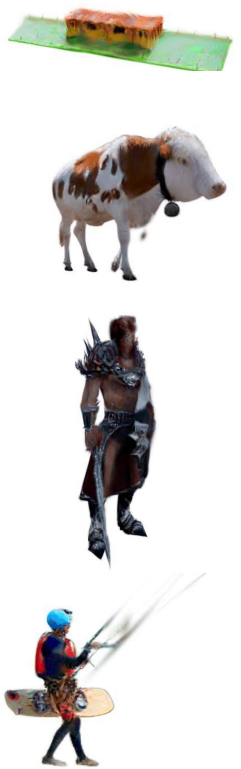
4D Generation



Input Video

Consistent4D

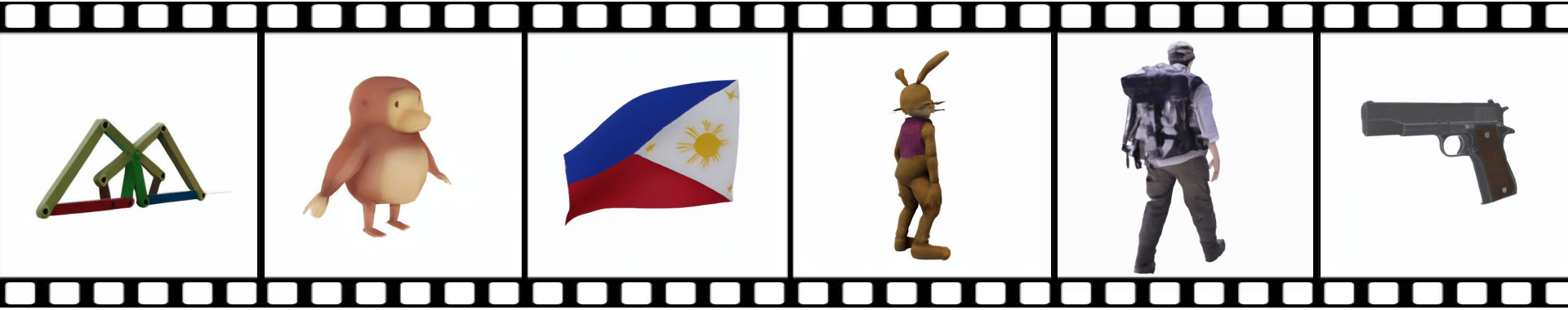
STAG4D



DreamGaussian4D

Stable Video 4D (Ours)

Take-Away Message



- SV4D can **simultaneously** generate **multi-view and multi-frame** images.
- SV4D sampling strategy enables sequential processing of **arbitrary long input videos**.